In-Stream Wetland Improves Water Quality

More and more newspapers are reporting concern about a major water pollution problem in the eastern United States—nonpoint source nitrogen in rivers. Numerous rivers and major bodies of water, including the Chesapeake Bay and the Gulf of Mexico, are plagued by high amounts of this nutrient.

Some of the nitrogen polluting these waterways comes from crop fields and grazinglands. Both natural and agricultural ecosystems have a certain amount of nutrient loss. That's because rainfall dissolves and leaches nitrogen and other nutrients from soil into nearby streams and rivers that eventually feed coastal bodies of water.

Nitrogen stimulates growth of aquatic flora and microbes, which often lower the amount of dissolved oxygen in the water. With little oxygen to sustain them, native fish and shellfish that are economically and environmentally important die or are displaced.

"We know that natural wetlands are one of the most effective ecosystems for transforming and removing agricultural and industrial nitrogen and other chemicals from water," says Agricultural Research Service soil scientist Patrick G. Hunt. "Wetlands are an excellent last line of defense for water quality."

Hunt evaluated the ability of a constructed in-stream wetland to remove nitrogen from a nitrogen-contaminated stream in the Herrings Marsh Run watershed in Duplin County, North Carolina. He worked with agricultural engineer Frank J. Humenik at North Carolina State University in Raleigh, along with agricultural engineer Kenneth C. Stone, soil scientist Terry A. Matheny, and agricultural engineer Melvin H. Johnson at the ARS Coastal Plains Soil, Water, and Plant Research Center in Florence, South Carolina. It was part of a USDA Water Quality Demonstration Project in the Coastal Plain of North Carolina.

"A wetland can be constructed when the landscape offers the opportunity for establishing a water-control structure," says Hunt. "Herrings Marsh Run provided us with good potential for establishing a wetland and cleaning up one of its streams.

MELVIN JOHNSON

An in-stream wetland removes excess nitrogen from a stream in the Herrings Marsh Run watershed in Duplin County, North Carolina.

"In this case, establishment was easy. After we stabilized the walls of a beaver dam, we created a 60- by 600-yard wetland. The water depth at the lower end was about 6 feet, but much of the area was less than 2.

"About 40 percent of the wetland's surface area was covered by aquatic weeds," Hunt says. "Another 40 percent was dominated by a perimeter of trees—swamp tupelo, red maple, and black willow. The remaining 20 percent was mostly open water."

The wetland was only 8 acres—less than 1 percent of the watershed that drained through it. Nevertheless, it dramatically lowered stream nitrate-N by 2.8 pounds per acre a day.

"That's about 50 percent of the nitrogen entering the wetland in a year," says Hunt.

The nitrate was likely being changed by bacteria to gaseous nitrogen through a process known as denitrification. Such denitrification was favored by the low-oxygen conditions in the wetland. Dissolved oxygen was generally less than 50 percent saturation throughout the wetland waters, and the sediment was dominated by an absence of oxygen.

Water entered the wetland at an elevated nitrate-N level—typically about 7 parts per million (ppm). During warmer months, it left the wetland with less than 1 ppm. In cooler months, when bacterial activity was lower, nitrate levels left the wetland as high as 5 ppm, but monthly nitrate levels were always lower in discharge water than in inlet water.

"Wetlands are a good complement to other best-management practices for improving water quality," says Hunt. "They are relatively inexpensive to build, simple to operate, aesthetically pleasing, and attractive to a variety of wildlife."—By **Hank Becker,** ARS.

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